Norfolk Flooding Strategy Overview

Norfolk Flooding Strategy

- Over the course of the past three years, the City has undertaken a comprehensive approach to address precipitation and tidal flooding across the entire City.

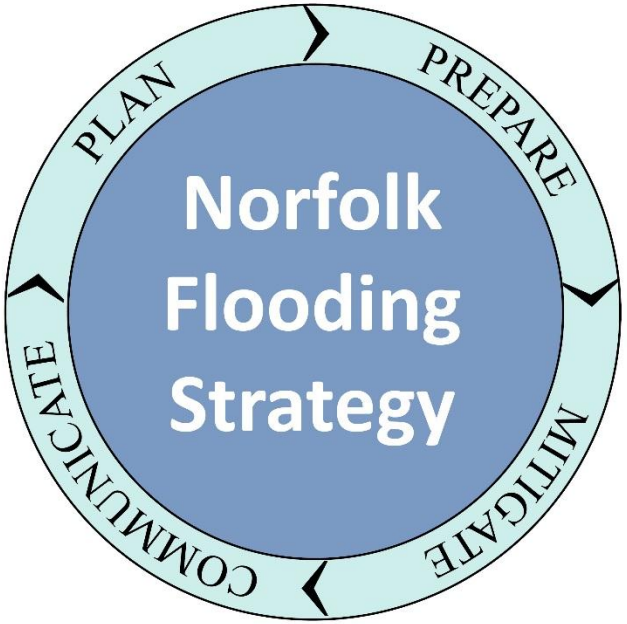
- Realizing the magnitude by which we must address this issue, our work plan has evolved into a four-pronged strategy.

Plan

- City planning
- Study and analysis
- Modeling & simulation

Prepare

- Emergency Preparedness & Response
- Education & Training



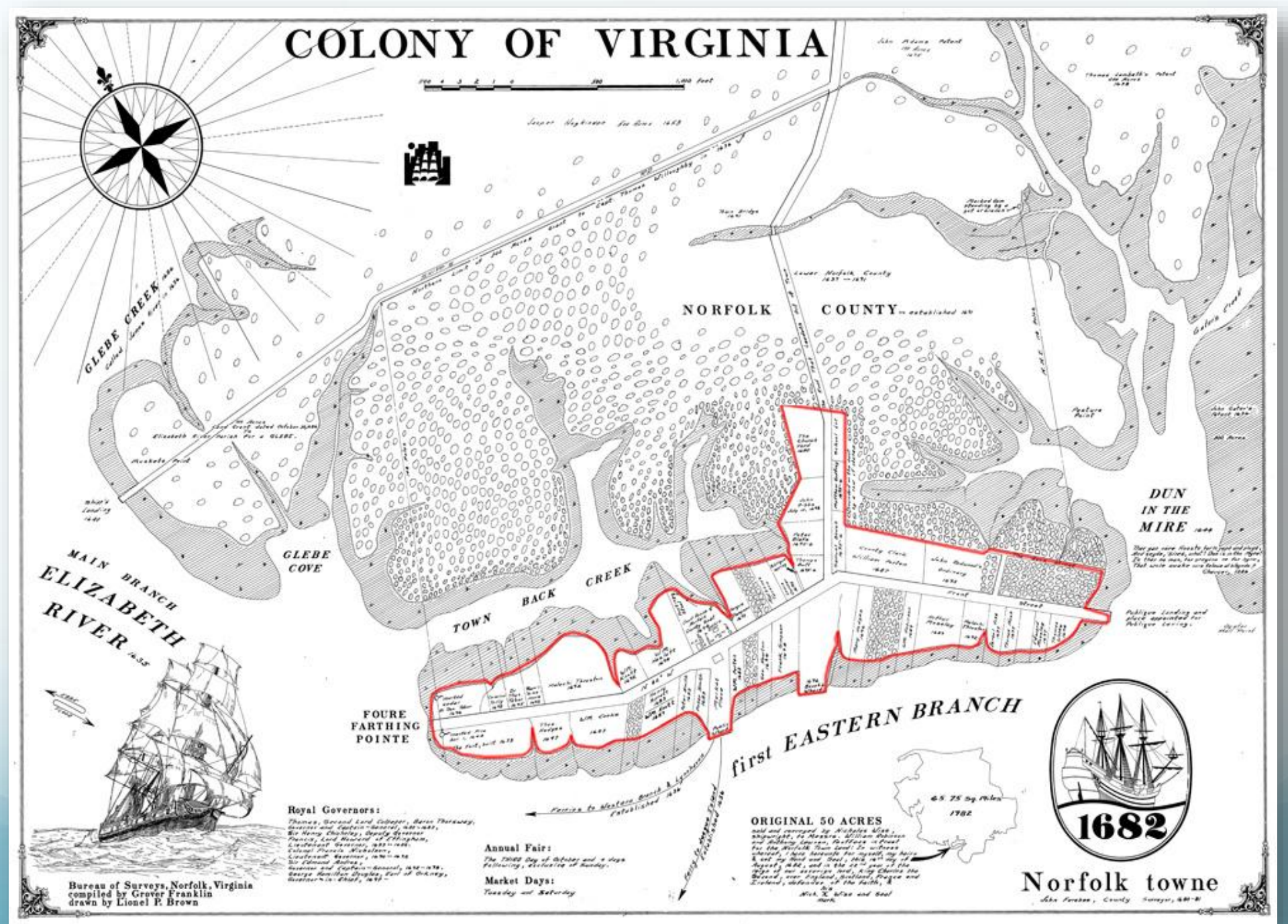
Communicate

- Citizen outreach
- Partnerships
- Online resources

Mitigate

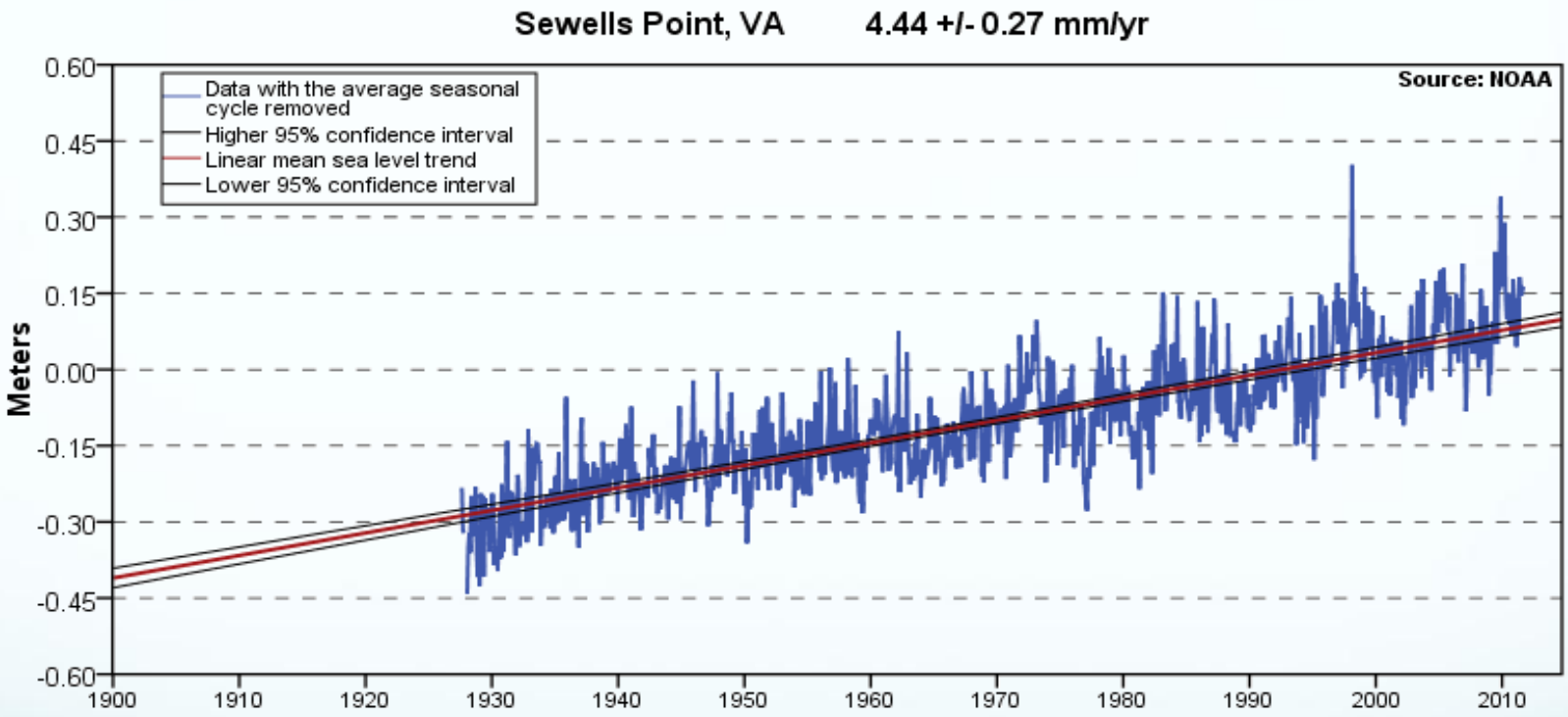
- Infrastructure development
- Flood remediation and mitigation

COLONY OF VIRGINIA



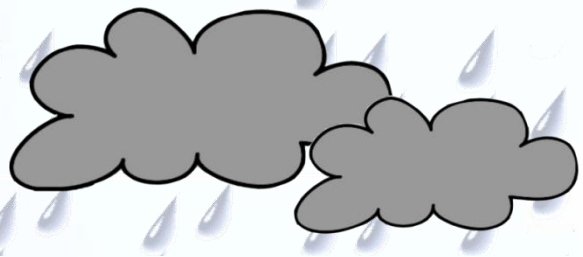
Bureau of Surveys, Norfolk, Virginia
compiled by Grover Franklin
drawn by Lionel P. Brown


NORFOLK'S ORIGINAL FIFTY ACRES
John Ferebee, County Surveyor 1680 - 1681
John Ward, City Surveyor 2006 - Present
This map depicts the original fifty acres of Norfolk overlayed upon 2013 imagery. This was created in multiple steps.
First, the original "Norfolk Towne, 50 Acres, 1682" map was scanned.
Next, city staff consulted with local historians to determine sites that still exist today.
Then, field crews were sent out to collect GPS coordinates on the previously determined locations.
Finally, the scanned image was georeferenced to the GPS points
and the fifty acre boundary was digitized by a city technician.
2013 imagery is property of Pictometry International.
Map composed October 2008, Updated 2013.
This map is for graphic purposes only.

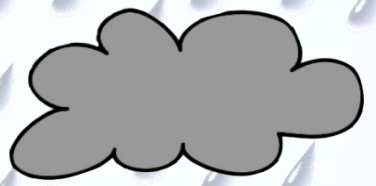

Sewells Point, VA 4.44 +/- 0.27 mm/yr
Source: NOAA
Data with the average seasonal cycle removed
Higher 95% confidence interval
Linear mean sea level trend
Lower 95% confidence interval
Meters
0.60
0.45
0.30
0.15
0.00
-0.15
-0.30
-0.45
-0.60
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010


Chesapeake Bay
Gloucester
James City
York River
Williamsburg
York
Inner Crater
Newport News
Poquoson
Surry
James River
Hampton
Outer Crater
Isle of Wight
Norfolk
Portsmouth
Virginia Beach
Suffolk
Chesapeake
Franklin

Engineering Basics – Living in the “Tidewater”

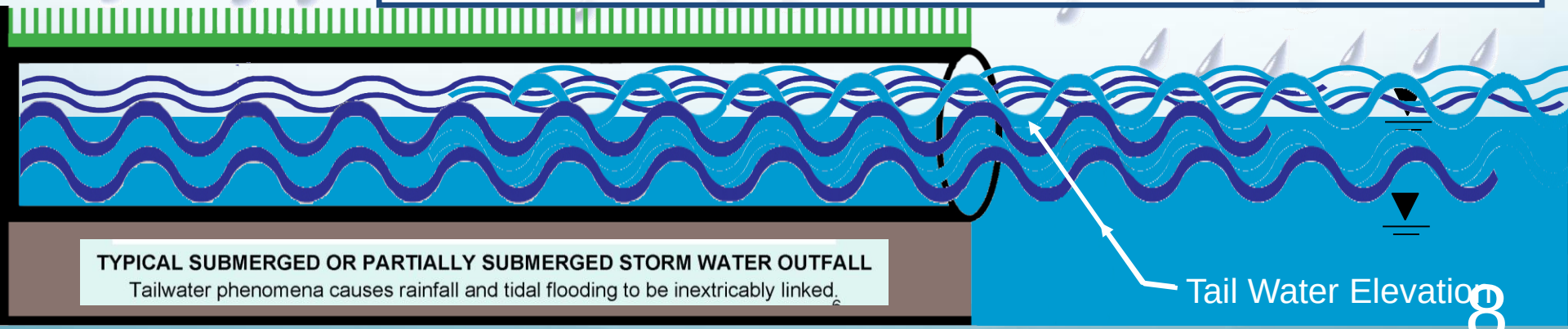


In the low-lands of Coastal Virginia rainfall runoff is typically hindered by flat topography and old infrastructure



Tidal Surge (&/or future SLR) reduces the gradient and slows transport of runoff, worsening flooding

IMPLICATION: Tidal Surge (&/or future SLR) both directly cause inundation and delay runoff from rainfall - thus worsening & extending the duration of storm flooding.



TYPICAL SUBMERGED OR PARTIALLY SUBMERGED STORM WATER OUTFALL
Tailwater phenomena causes rainfall and tidal flooding to be inextricably linked.

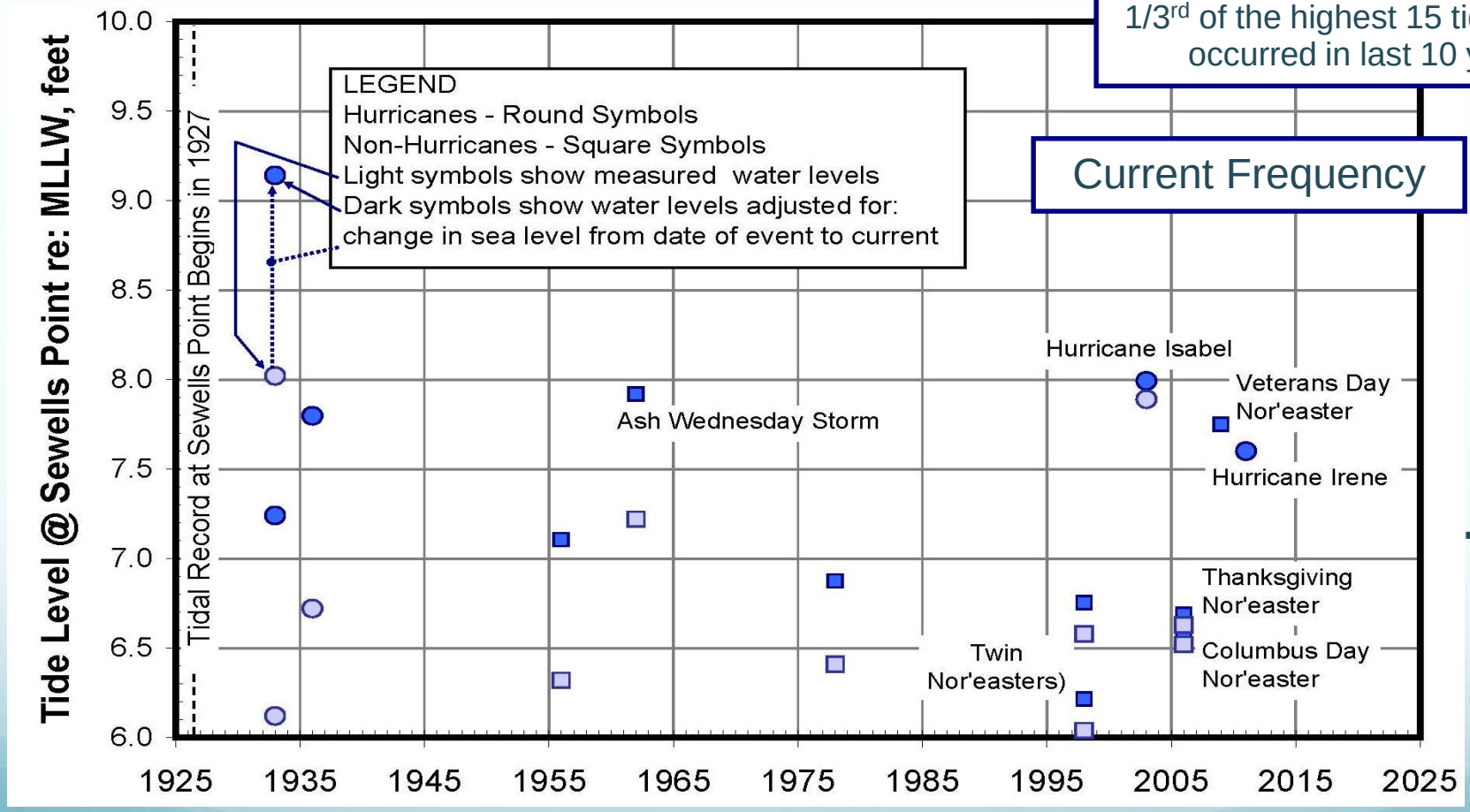
Highest Recorded Tide Events at Sewells Point

- The Sewells Point Tide gauge provides the longest records along the US East Coast

Of highest tidal events since 1927:

1/2 of the highest 6 tide events

1/3rd of the highest 15 tide events occurred in last 10 years



Current Frequency

Every 11 years

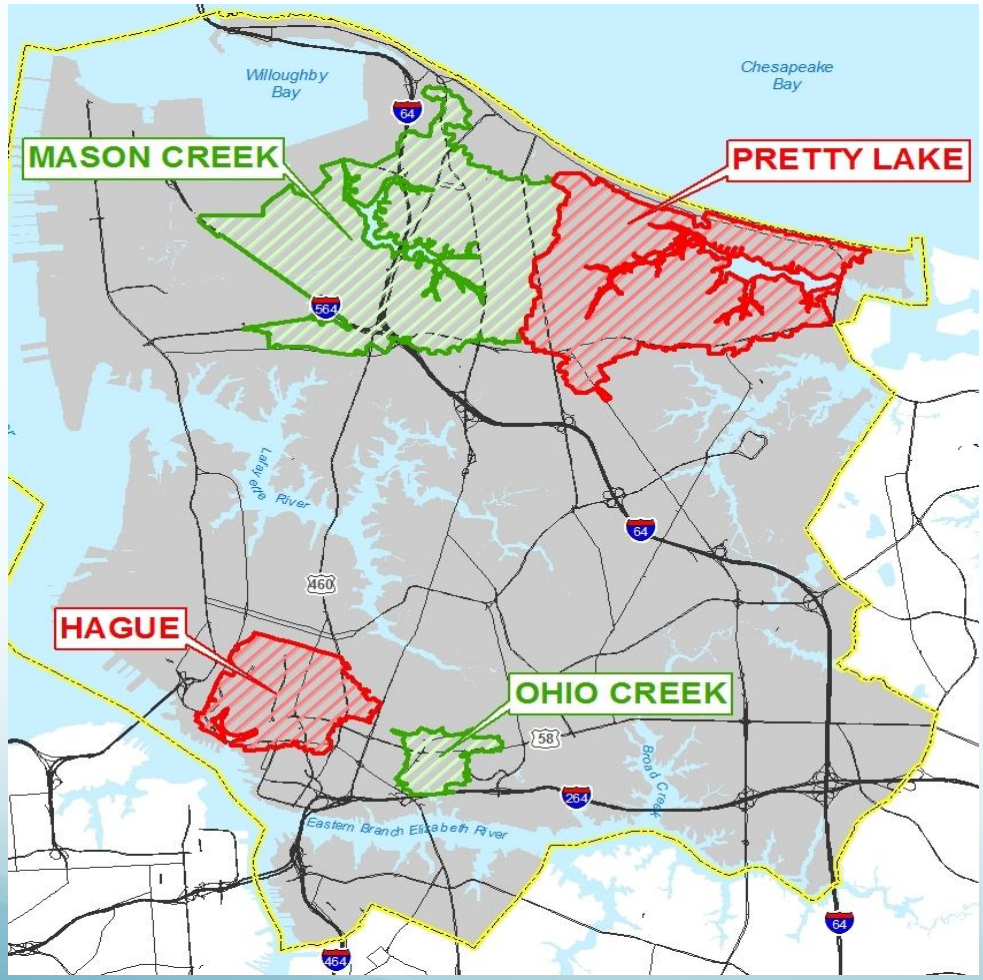
Every 6 years

Every 3 years

Each 1-foot of SLR will increase the frequency by a factor of ~3X

Every 6 years will become every 2 years & every 3 years will become every year

Norfolk Coastal Flooding Study: Initial Focus



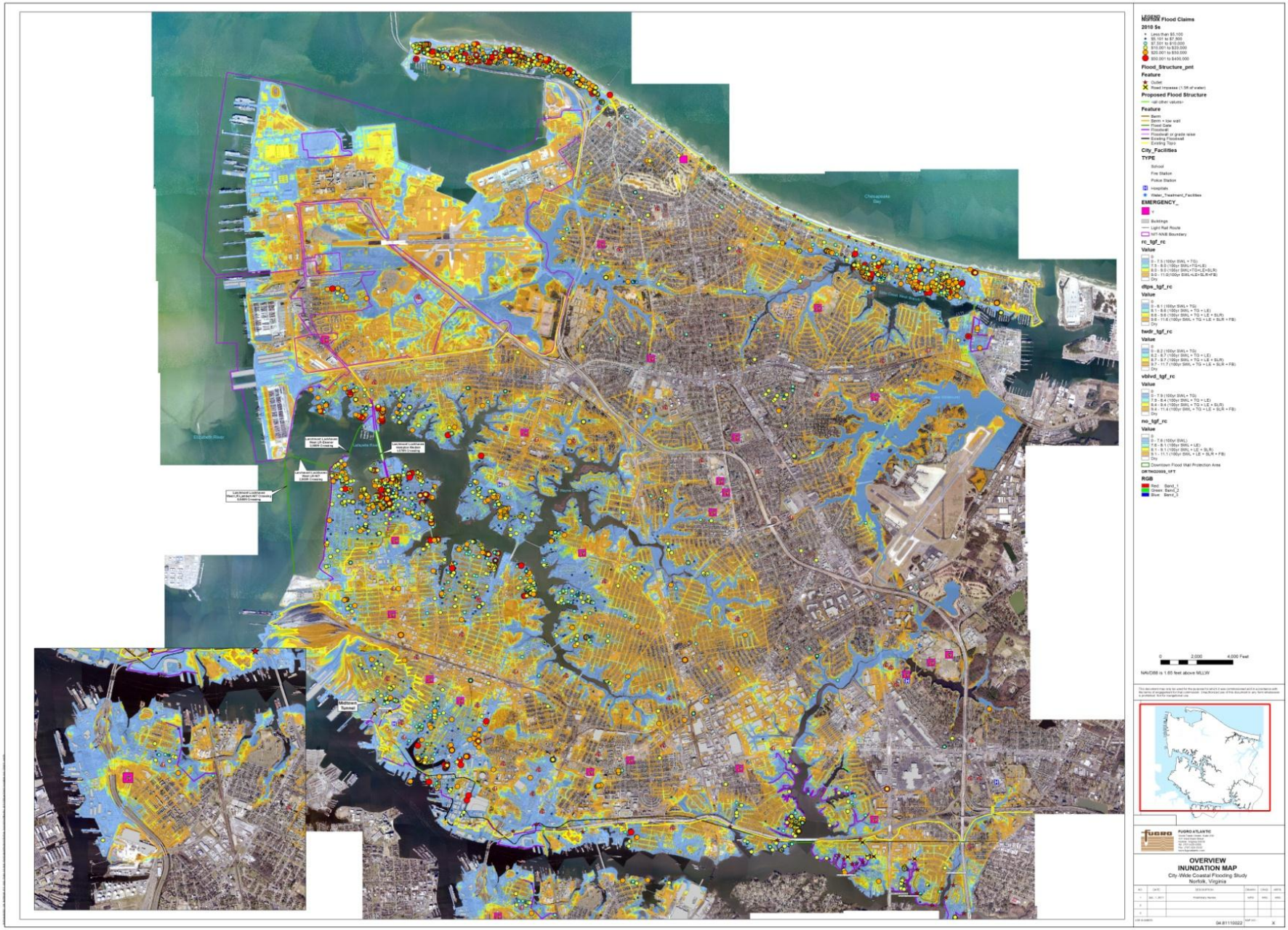
Choices based on:

- **Geographic setting areas with narrow tidal mouths (natural constriction points)**
- **Watersheds which were expected to lend themselves to specific, basin-wide mitigation options (simpler cases)**
- **Areas of recurring damage**

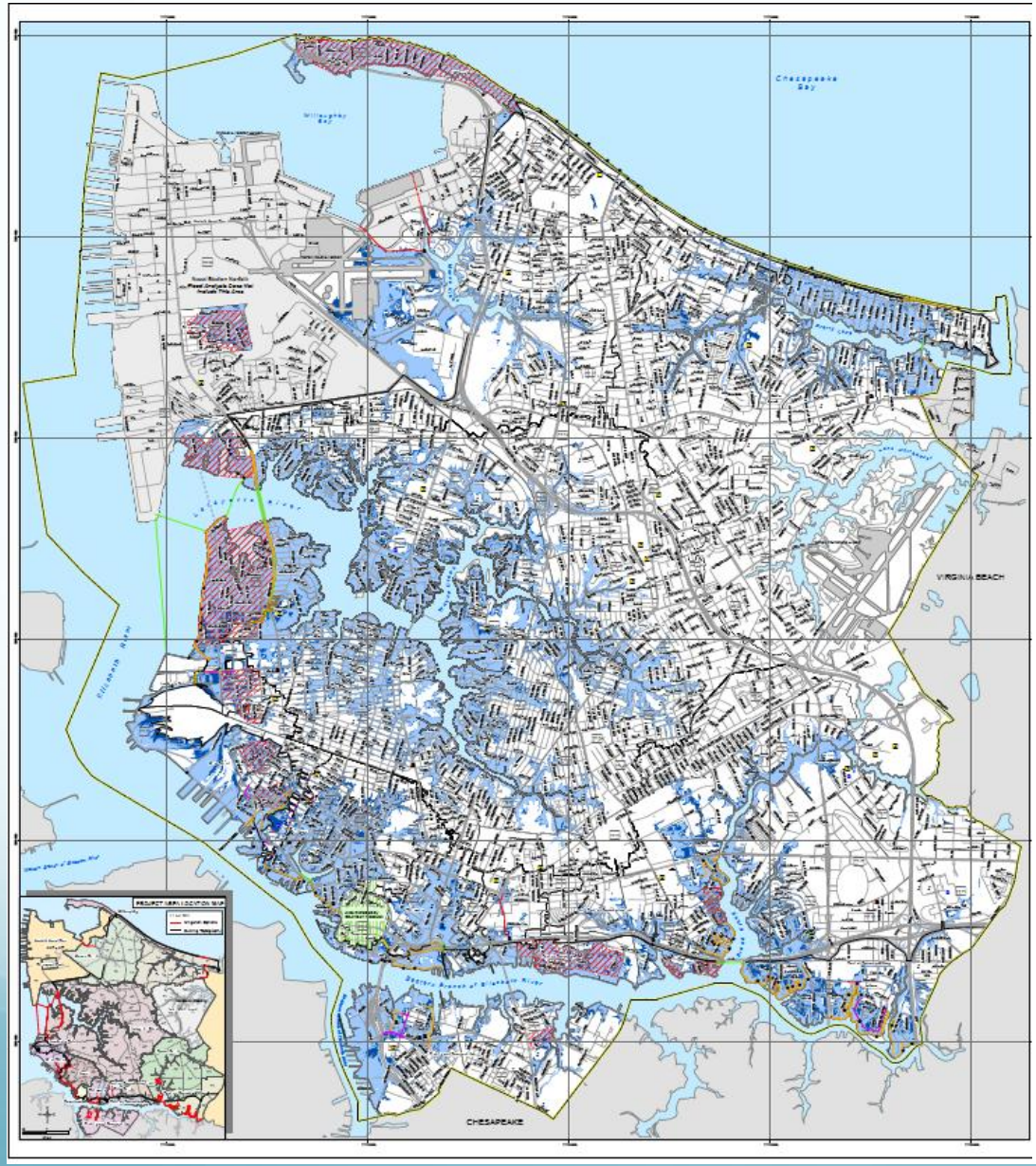
Coastal Flooding Study: Citywide Report

- This study performed by Fugro Atlantic builds upon previous phases of work and identifies flood mitigation options throughout the City.
- Using various water levels, a GIS-based model was developed to predict coastal flooding extents and depths throughout the City.
- Flood mitigation concepts identified include policy, education, building codes, elevation of buildings and roadways, and infrastructure.

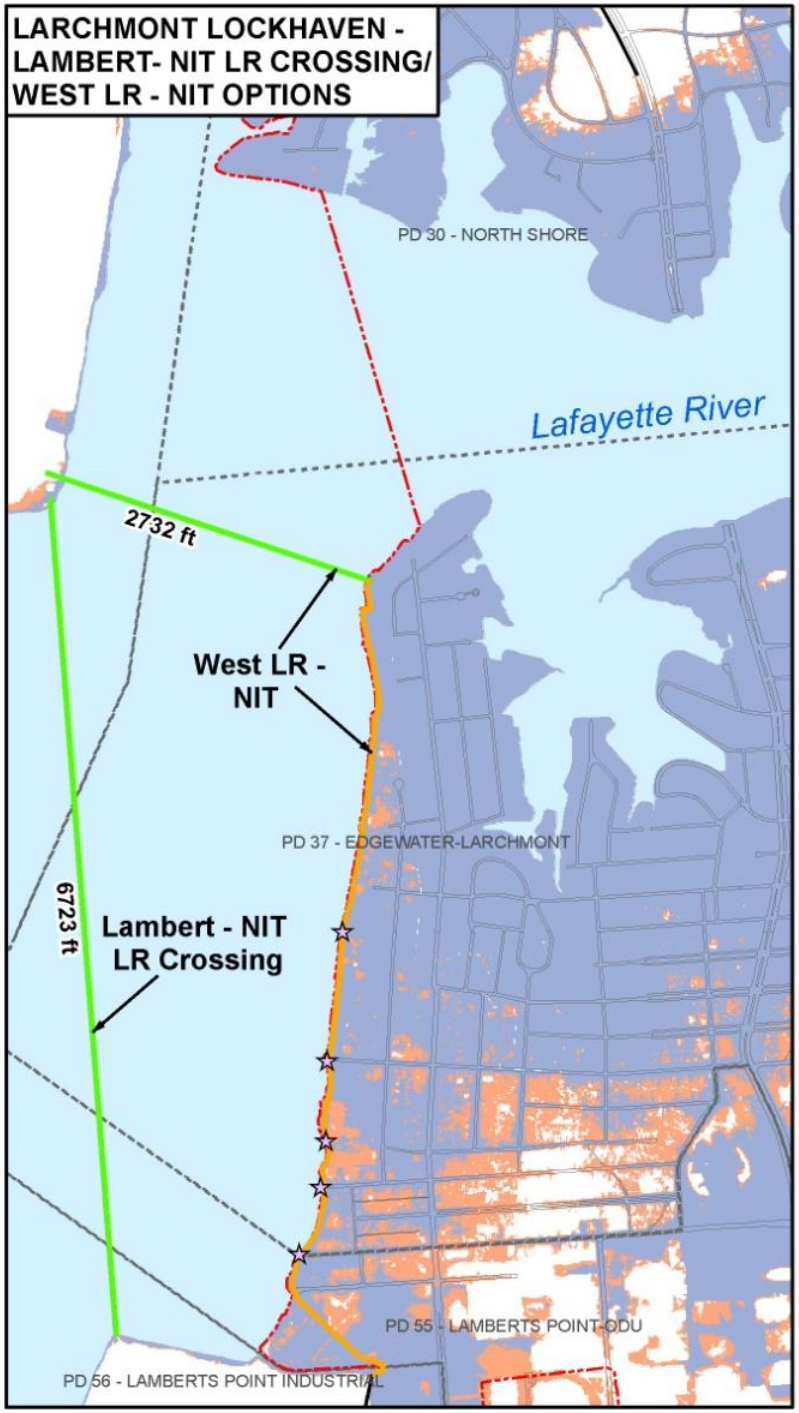
Citywide Risk Analysis & Options



Coastal Flooding Study: Summary



- 15 project areas were identified totaling over $300 M
- Options generally include a flood barrier system across the basin outlet and for areas outside the barrier, elevating structures or floodproofing is recommended
- The most extensive project option identified is the Lafayette River watershed which comprises 26% of the City's land mass
  - The Lafayette River and Tidewater areas were identified for potential multi-use projects that could incorporate a combination of flood mitigation infrastructure and transportation or recreational facilities (ie roads, rail, bike paths, etc.)



Coastal Flooding Mitigation Option:

Lafayette River Project Area

- Project area is 26% of City's total area
- 48,259 acres with 22,838 houses and non-residential buildings
- History of severe flooding and repetitive loss claims predicted to account for 49% of total damages citywide.
- Minimum project costs estimates range from $175 M - $300 M

Mitigation Options

- Road Raise
- Berm
- Flood Gate
- Floodwall
- Culvert
- Existing Floodwall
- Existing Topography
- Feature with Yellow Highlight Required for 1-foot of Sea Level Rise
- House Raising
- Outfall Flap Valve
- Pump Station

LEGEND

- Project Area
- Planning District Boundary

Approximate Coastal Flooding
Does not include precipitation.

- 1% Annual Chance Coastal Flood Extent
- 1% Annual Chance Coastal Flood Extent with 1-Foot Sea Level Rise

Precipitation Flooding Study & Drainage Master Plan

- Precipitation Drainage Master Plan finalized by Timmons Group in November 2012
- Analyzed 253 city stormwater drainage watersheds
- Developed a Quantifiable Scoring (Prioritization) System
- Analysis aggregated into Planning Districts

Precipitation Flooding Study: Summary

- It was determined that 17% of road miles in the City require drainage and roadway improvements
- A total of 445 project areas were identified within the 87 planning districts
- The total estimated costs range from $550 M - $770 M

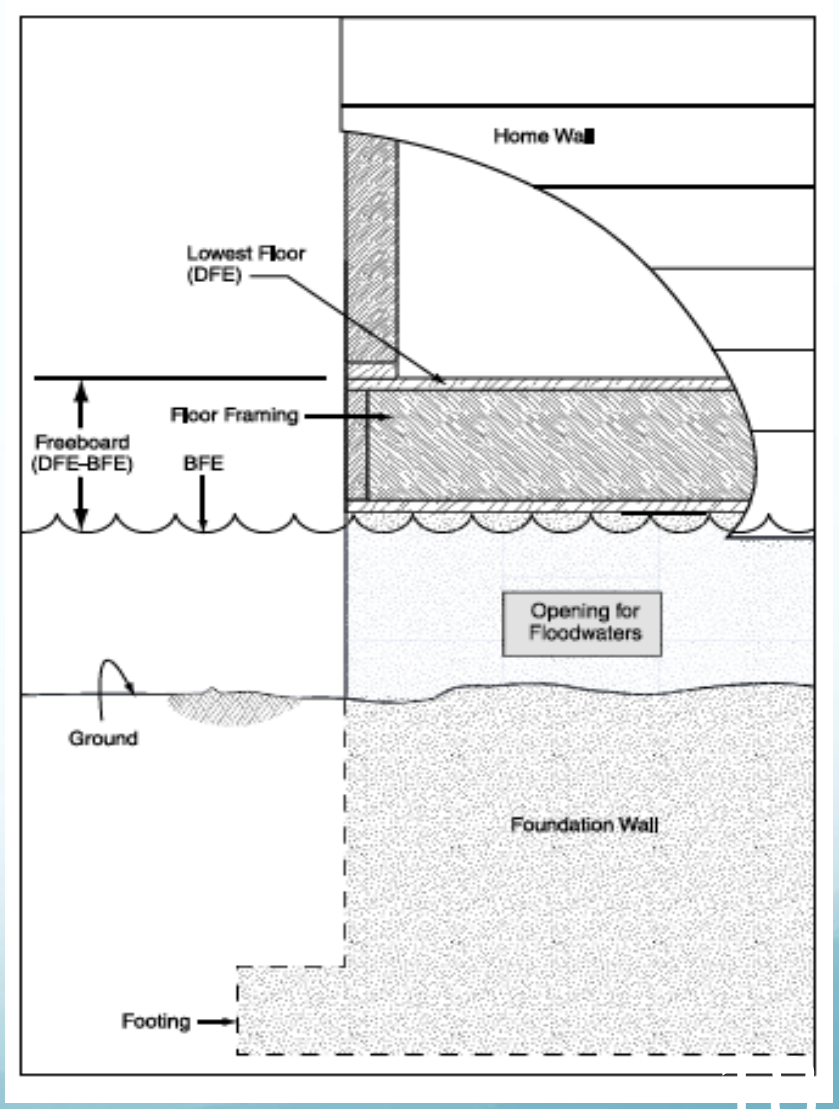
Progress of Studies by the US Army Corps of Engineers

- After a decade of study, the General Reevaluation Report for the Ocean View beaches is complete.
  - The total estimated construction costs for a protective berm totals $18.4 million and Norfolk's share is estimated just below 30% at $5.5 million.
- Hague and Pretty Lake Reconnaissance Studies are nearly complete and the projects will likely move on to the Feasibility phase under the Section 205 Continuing Authorities Program.
- Approval is pending for a comprehensive citywide study of Norfolk under the Hurricane Sandy Comprehensive Relief Bill

Development Standards and Procedural Changes

New development requirements have been adopted and procedural changes to enhance flood resilience for properties which in turn will lower insurance rates.

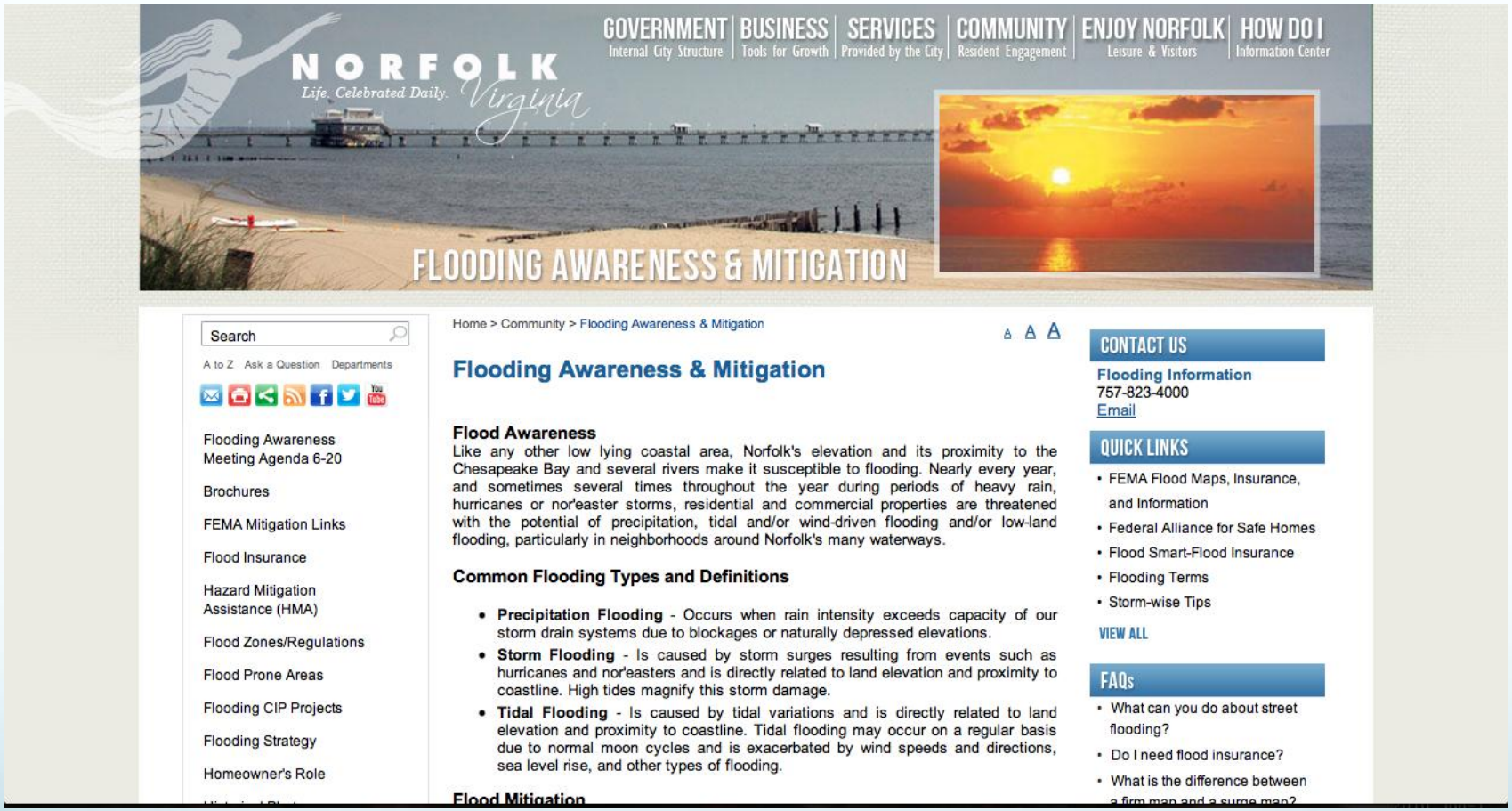
The new standard is 3 feet above base flood elevation.



Brambleton Mitigation Project Underway

$2.4 M project will raise westbound lanes to reduce frequency of flooding and provide enhanced access to Fort Norfolk and the Medical Complex

Communication Activities



Seeking Private Sector Investment

Re.invest Initiative cities include: El Paso, Hoboken, Honolulu, Miami, Milwaukee, New Orleans, Norfolk and San Francisco

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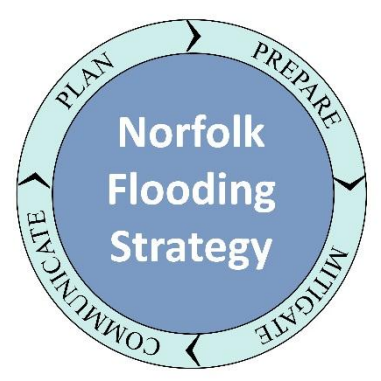

Alameda, California, USA
Berkeley, California, USA
Boulder, Colorado, USA
El Paso, Texas, USA
Jacksonville, Florida, USA
Los Angeles, California, USA
New Orleans, Louisiana, USA
New York City, New York, USA
Norfolk, Virginia, USA
Oakland, California, USA
San Francisco, California, USA

Medellin, Colombia
Mexico City, Mexico
Porto-Alegre, Brazil
Quito, Ecuador
Rio de Janeiro, Brazil
Bristol, UK
Glasgow, UK
Rome, Italy
Rotterdam, Netherlands
Vejle, Denmark
Ashkelon, Israel

Byblos, Lebanon
Ramallah, Palestine
Dakar, Senegal
Durban, South Africa
Bangkok, Thailand
Da Nang, Vietnam
Mandalay, Myanmar
Semarang, Indonesia
Surat, India
Christchurch, New Zealand
Melbourne, Australia

NATIONAL INSTITUTE FOR
COASTAL & HARBOR INFRASTRUCTURE

Mission Statement

www.NICHIUSA.org

- The National Institute for Coastal and Harbor Infrastructure is nonprofit entity established to advocate for an expanded federal role in coastal climate adaptation.
- Our national economy and our national security are imperiled by the triple threat of rising sea levels, extreme weather events and aging infrastructure.
- Our choice is clear. We can either respond to the magnitude and urgency of this crisis with a continuing cycle of local and regional disaster relief, repairing our 20th Century infrastructure at great cost in lives and property, or we can develop and fund a national program to assist our cities and states in the cost effective implementation their climate adaptation plans, protecting our communities while revitalizing our coastal economies with state of the art technology, innovative transportation systems, modern port facilities and non infrastructure solutions.
- NICHI is committed to building a broad national coalition of private and public interests to advocate for a national interstate coastal infrastructure system that integrates, enhances and funds local, regional and state coastal climate adaptation plans.
- William B. Golden is a former Massachusetts State Senator who has participated in the creation of the United States EPA, NOAA, The Massachusetts Water Resources Authority, the Urban Harbors Institute and Save the Harbor Save the Bay and rode out Super Storm Sandy in New York aboard the Nantucket Lightship (WLV612).

How Unique was Sandy?

- Track-line Plot of Tropical Storms, Hurricanes and Superstorms since 2000
- Sandy was unusual, but not unique
- Many believe (and the a study by the Virginia Institute of Marine Sciences suggests) that Sandy is a forerunner of the future and not a one-of event